(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 April 2001 (05.04.2001)

PCT

(10) International Publication Number
WO 01/23653 A1

(51) International Patent Classification[7]: D04B 1/14, D03D 15/00, D04C 1/02

(21) International Application Number: PCT/GB00/03586

(22) International Filing Date:
19 September 2000 (19.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/406,490 27 September 1999 (27.09.1999) US
09/612,038 7 July 2000 (07.07.2000) US

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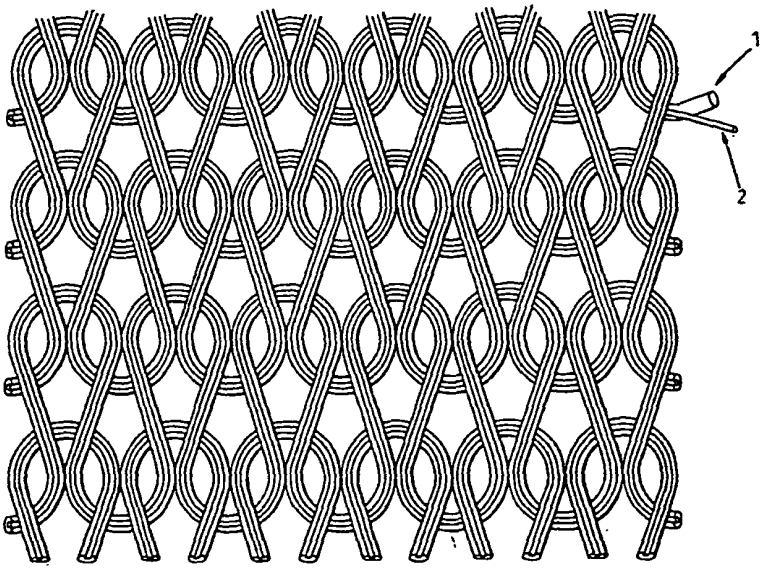
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ABSORPTIVE FABRIC



(57) Abstract: A composite fabric comprising a combination of a gel-forming yarn and a reinforcing yarn. A method of making a reinforced absorptive fabric comprising the steps of weaving, knitting or braiding together gel-forming yarn with reinforcing yarn, such that the network of reinforcing yarn provides structural integrity to the fabric independent of the gel-forming yarn. A composite fabric or structure may also comprise a composite yarn in which is incorporated both gel-forming fibre and reinforcing fibre. Gel-forming fabrics or structure may be made by first forming fabrics or structures of gel-forming fibre precursor and then converting the precursor to its gel-forming state.

WO 01/23653 A1

ABSORPTIVE FABRIC

FIELD OF INVENTION

The present invention pertains to fabrics that are capable of absorbing a relatively large quantity of a fluid. Certain embodiments of such fabrics are particularly useful for the control of bleeding.

BACKGROUND OF INVENTION

It is known to use, for various medical and other purposes, fibrous materials, including yarns, which gel when wet and which absorb body fluids. Such materials are used as swabs during surgery, as hemostatic agents and wound dressings. The problem with such materials is that they tend to become weak when wet. Structures formed from these materials tend to break or lose integrity upon absorption of blood or body fluids.

Among the materials used for this purpose are collagen, oxidized cellulose, calcium alginate and hemostatic gelatin. Such materials will be

referred to generically herein as gel-forming materials and yarns made therefrom as gel-forming yarns.

One particular material of this kind is sodium carboxymethylcellulose (CMC), staple fibre forms of which are used in non-woven fabrics that are commonly used in post-trauma and post-surgical situations as wound dressings. CMC gels upon contact with water, blood or body fluids, and swells to absorb such materials. CMC also facilitates blood clotting while absorbing any exude and is, therefore, hemostatic. In addition, it is well known that CMC is hydroscopic so it does not readily dry into clotted blood, and therefore can be removed easily without causing re-bleeding. If it does dry, it can be easily re-gelled by wetting with water or saline solution.

A composite structure, incorporating gel-forming fibres and conventional textile fibres, is disclosed in international patent application, WO 98/46818. The materials described in WO 98/46818 as gel-forming fibres are essentially the same as those which are useful, in yarn form, in the present invention.

In the structure disclosed in WO 98/46818, the gel-forming fibres are said to be "laid-in" to a knitted fabric. Applicant believes, however, that a knitted structure as disclosed there would, to a significant degree, lose its physical integrity upon gelling of the gel-forming fibres and would not be

suitable in an application in which the fabric is stretched when the gel forming fibres are gelled.

SUMMARY OF INVENTION

The present invention provides a composite knit, woven or braided fabric comprised of a combination of gel-forming yarn and reinforcing yarn, wherein the reinforcing yarn is knit, woven or braided such that the fabric is capable of retaining its structural integrity independent of the gel-forming yarn.

In one embodiment of the present invention, the gel-forming yarn is composed of a hemostatic material such as sodium carboxymethylcellulose (CMC).

Typically the reinforcing yarn is a thin strong synthetic material, such as nylon.

In the knit, woven or braided fabric of this invention, the gel-forming yarn may follow the same yarn path as some or all of the reinforcing yarn courses. The gel-forming yarn may also follow a different path by which it is laid in or interwoven with the reinforcing yarn.

In one form of the present invention, the fabric may be made by weaving, knitting or braiding a composite fabric comprised of reinforcing yarn and a gel-forming yarn such as oxidized cellulose or CMC. Alternatively, such a fabric may be made by weaving, knitting or braiding, with a reinforcing yarn,

a cellulosic yarn, the woven, knit or braided structure being such that the structural integrity of the fabric is dependent on the reinforcing yarn only, and then converting the cellulosic yarn therein to oxidized cellulose or sodium carboxymethylcellulose.

This conversion process is conventional and requires only that the reinforcing yarn be resistant to chemical attack in the conversion process. The cellulosic yarn thus converted is in fact gel-forming, highly absorptive and may be hemostatic. In knit form, the resultant fluid absorbing fabric is stretchable, to the degree the reinforcing yarn and/or the structure of the fabric is stretchable. Such a fabric retains its structural integrity even when stretched and when the gel-forming yarn has absorbed water or blood or body fluid and formed a gel therewith.

This conversion process may be useful also with unreinforced knitted, woven or braided cellulosic fabric, that is cellulosic fabrics without reinforcing yarn, and to non-woven structures comprised of precursors of gel-forming fibres or yarns.

Still another form of reinforced gel-forming absorbent fabric, within the scope of this invention, may be made by forming the fabric or other structure with a composite yarn, the yarn itself comprising a composite or combination of gel-forming fibre (or a precursor thereof, convertible as

described above) with a reinforcing fibre. Such a composite yarn may comprise a yarn spun from a combination of such fibres or a core spun yarn, wherein the core fibre is a continuous strand of a reinforcing filament, or filaments, made of a material such as nylon.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a diagrammatic view of one knitted embodiment of the present invention.

Figure 2 is a diagrammatic view of another knitted embodiment of the present invention.

DETAILED DESCRIPTION OF INVENTION

The present invention, in one embodiment, comprises a composite fabric, which retains its structural integrity while absorbing a large quantity of fluid, and particularly to such a fabric useful for the control of bleeding. One application for such a fabric is in an expandable hemostatic device for the control of bleeding in body cavities, as disclosed and claimed in a separate patent application of partial common inventorship herewith, U.S. Application Serial No. 09/406/166, filed September 27, 1999.

As used herein, the term "hemostatic" refers to a material that retards or prevents bleeding. Some gel-forming materials, such as CMC, are hemostatic. The term "reinforcing" yarn refers to a yarn that has greater

tensile strength in a wet phase than a gel-forming yarn with which it is combined.

The word "yarn," as used herein, refers to an indefinite length of material suitable for weaving, knitting or braiding, typically comprised of one or more continuous strands of material or a multiplicity of relatively short length fibres spun into a fibre bundle of indefinite length, or some combination of continuous strands and spun fibres.

Gel-forming materials or yarns, of the type generally referred to herein, typically soften to form a gel or partially dissolve when brought into contact with a suitable liquid such as blood. Such a material absorbs liquid and will absorb many times its own weight. Certain gel-forming materials are referred to as hemostatic because they tend to cause blood to clot while absorbing any exudate. Hemostatic, gel-forming materials, such as CMC, are particularly useful for medical purposes wherein the absorption of body fluids is important. Such materials are also used during surgery, or other medical procedures, as hemostatic agents and wound dressings.

The composite fabric of the present invention comprises a reinforcing yarn woven, knitted or braided with a gel-forming yarn. Typically, the reinforcing yarn is a relatively strong synthetic material, with which the gel-forming yarn is placed side by side during the weaving, knitting or braiding of the gel-forming and reinforcing yarns into a woven, knitted or braided fabric.

Alternatively, all or less than all of the yarn courses of the reinforcing yarn may be accompanied by gel-forming yarn. Alternatively also, still other yarn courses or picks of the woven or knitted fabric may comprise gel-forming yarn only, so long as the network of woven or knitted reinforcing yarn retains its structural integrity independent of the gel-forming yarn.

In general, it is preferred for present purposes to maximize the proportion of gel-forming yarn in the fabric and incorporate as little as possible of the reinforcing yarn, while still ensuring adequate strength in the fabric after the gel-forming yarns have gelled. As a practical matter, at least 5% (by weight) of reinforcing yarn is required but a larger proportion of reinforcing yarn may be used to yield a fabric of greater strength.

CMC, a preferred gel-forming material in the present invention, may be made by the chemical conversion of a variety of cellulosic materials, such as viscose rayon, cotton, etc. One cellulosic yarn suitable for the present invention is a Lyocell yarn. It is available from Spinneroff Streif AG, Zurichstrasse 170, Uathal, Switzerland. Lyocell is a solvent spun cellulose, produced from the natural cellulose in wood pulp by dissolution of the pulp in a solvent and then extruding the solution through a multiple-hole die, called a spinneret, to form a yarn comprised of a plurality of continuous strands. The solvent is vaporized in the process, leaving a continuous multi-filament yarn composed of pure cellulose.

The filaments in such a yarn may be chopped into staple form and spun into a yarn in a way similar to that used in processing cotton fibre.

In accordance with one aspect of the present invention, such an unconverted cellulose yarn is readily woven, knit or braided into a precursor fabric, from which the fabric of the present invention is made by conversion of the cellulose to sodium carboxymethylcellulose or to oxidized cellulose, in accordance with well-known techniques.

In the conversion of cellulose to sodium carboxymethylcellulose, less than all of the cellulose building blocks may be converted to the sodium carboxymethylcellulose form and the degree of this conversion will dictate the degree to which a resultant CMC yarn will absorb water and form a gel therewith. This proportion is sometimes referred to as the conversion factor. While the present invention is not limited to sodium carboxymethylcellulose of any particular conversion factor, such materials with a conversion factor of 50 to 70% are preferred in the fabric of the present invention.

Oxidized cellulose, which is conventionally used in knitted form as a hemostatic agent during surgery, may also be used in the reinforced fabric of the present invention and may also be converted (oxidized) after cellulosic yarn is first woven, knit or braided into a precursor fabric.

Yet another hemostatic material, useful in the present invention, is calcium alginate, which is a material derived from seaweed, and, in matted fibre

form, is also used as a wound dressing. Other fibrous polysaccharides, with similar chemistry and properties to CMC, may also be used.

Combinations of different gel-forming agents may be used within the scope of the present invention. Such combinations may be made by forming a yarn from different gel-forming or hemostatic fibres and/or by weaving, knitting or braiding combinations of different gel-forming yarns.

In the case where a precursor fabric is first formed with cellulose yarn, and the knitted, woven or braided cellulose yarn is then converted to gel-forming oxidized cellulose or sodium carboxymethylcellulose, the reinforcing yarn must be non-reactive with the reactants and the products of the process of converting the cellulosic material into the gel-forming, chemically modified form thereof.

Referring to Figure 1, the step of weaving, knitting or braiding involves conventional methods, which are known. In accordance with the present invention, each of the multiple yarn end feeds to a weaving loom, knitting machine or braiding machine may comprise, in effect, two yarn ends, fed in parallel, one the gel-forming yarn (or a precursor yarn suitable for subsequent conversion to a gel-forming yarn), and one the reinforcing yarn. With a weft knit fabric constructed in this way as an example, the knit fabric product would include, as shown in Figure 1, a thin reinforcing yarn 2, combined in all yarn courses with a thicker (but weaker) yarn 1, which is either

a gel-forming fibre or is convertible to a gel-forming yarn (i.e. a gel-forming yarn precursor).

In such a structure, at least some of the gel-forming yarn courses may be omitted, depending on the relative degree of strength and absorptive capacity desired. Shown in Figure 2 is another knit fabric of the present invention. Reinforcing yarns 3 are knit so as to provide structural integrity to the fabric, while gel-forming (or precursor to gel-forming) yarns 4 are inlaid therewith. The inlaying of gel-forming yarns 4 is such that even if the gel-forming yarns 4 are fully dissolved, the network of reinforcing yarns will maintain the structural integrity of the fabric.

Knit forms of the composite fabric of this invention have some inherent stretchability. In certain embodiments of the fabrics, such as those shown in Figures 1 and 2, still more stretchability may be provided. More specifically, the reinforcing yarn itself may be stretchable so that the fabric itself is more stretchable. This is particularly useful when the fabric is intended for disposition around a balloon-expanding device, as described in the above-referenced co-pending U.S. patent application. For that purpose, a tubular fabric is preferred.

In fact, one particularly effective use for the fabric of the present invention is as a hemostatic shroud covering an expansible device, adapted for disposition in a body cavity or passageway, such as a nasal passageway, to

control bleeding therein, as disclosed in the above-referenced U.S. Patent Application Serial No. 09/406,166, filed September 27, 1999.

While the range of fabrics required for different applications is very wide, an exemplary fabric, made for use in a nasal hemostatic device, comprises a knit construction, as illustrated in Figure 1, knitted into a tubular form in accordance with well-known methods. In this exemplary fabric, a gel forming precursor yarn (12 tex lyocell spun yarn is knit together with a reinforcing yarn comprised of 17 decitex 3 filament nylon. The fabric structure is a plain weft, knitted in circular form with 36 needles. The loop length is 5 mm and the weight of the finished fabric is 1.6 grams per metre (wet relaxed and dried to normal moisture regain). The reinforcing yarn comprises about 12%, by weight, of this fabric before conversion of the Lyocell to CMC and about 11% after that conversion.

The conversion of the Lyocell in this exemplary fabric is accomplished by methods well known in the art.

While the nylon reinforcing yarn used in this embodiment would not be considered stretchable, the fabric structure itself is stretchable and deformable, that is it will expand in diameter at the expense of its length.

Apart from the composite fabric as described above, the present invention also includes the process of making a gel-forming or hemostatic structure, including a matted fibre or laid-in knit structure, as disclosed in the

above-referenced WO 98/46818, by first forming the structure with gel-forming fibre precursors, such as cellulose fibre or yarn, and then converting the structure to the gel-forming state thereof, namely oxidized cellulose or CMC.

Still other composites and fabrics within the scope of this invention comprise a composite yarn, the structure of which includes both reinforcing fibres, such as nylon, and gel-forming fibres (or precursors thereof).

The most elementary method of combining two different fibres within one yarn is to simply spin the yarn from a mixture of the two fibres in staple form. However, this may lead to an overly weakened yarn once the gelling has taken place.

A preferred example of such a composite yarn is a core spun yarn, that is a yarn wherein staple fibres are spun around a preformed yarn. This preformed yarn may be another spun yarn, or, more commonly, a continuous filament yarn. This preformed yarn may comprise a reinforcing material, such as nylon. Gel-forming, or precursors of gel-forming, fibres comprise a second component of the final yarn product. The gel-forming fibres therein (converted from precursor materials either prior to or after spinning) provide absorptive and hemostatic capacity to the yarn and the reinforcing fibres or central filament of the preformed yarn provide strength. Such a yarn may be woven, knit or otherwise incorporated into a fabric or other structure, wherein fluid or blood absorption are important.

While the product and method of making the product of this invention have been described in connection with several specific embodiments, it should be understood that numerous modifications could be made by persons of skill in this art without departing from the true spirit and scope of the invention. Accordingly, the above description is intended to be merely illustrative and not limiting. The scope of the invention claimed should be understood as including all those alternatives and modifications which may be devised by one skilled in the art from the above description while nevertheless embodying the true spirit and scope thereof, and all equivalents or obvious variants thereof.

What is claimed is:

1. A composite knitted, woven or braided fabric comprising a combination of:

yarn which is either gel-forming or is a precursor yarn, capable of being converted to a gel-forming yarn; said gel-forming yarn or gel-forming yarn precursor being woven, knitted or braided with a reinforcing yarn, the knitting, weaving or braiding of such reinforcing yarn comprising a network capable of providing physical integrity to said fabric independent of said gel-forming yarn or gel-forming yarn precursor.

2. The fabric of claim 1 wherein said gel-forming yarn precursor is a cellulosic yarn.

3. The fabric of claim 1 wherein said gel-forming yarn is comprised of sodium carboxymethylcellulose.

4. The fabric of claim 1 wherein said gel-forming yarn is selected from the group consisting of sodium carboxymethylcellulose, oxidized cellulose, and calcium alginate.

5. The fabric of claim 1 wherein said reinforcing filament is a nylon continuous mono or multifilament yarn.

6. A composite fabric comprising a woven, knit or braided combination of:

one or more yarns capable of gelling upon contact with liquid, and

one or more reinforcing yarns,

wherein said reinforcing yarn has greater tensile strength than said gelling yarn in a wet phase, and

wherein said fabric is highly absorbent to blood and body fluids and

wherein the woven, knit or braided network of said reinforcing yarn is capable of providing structural integrity to said fabric independent of said yarn capable of gelling upon contact with liquid.

7. A method of making a composite fabric comprised of a combination of gel-forming yarn and reinforcing yarn, said method comprising the steps of:

weaving, knitting or braiding together a plurality of courses of said gel-forming and said reinforcing yarns,

said plurality of yarns including at least one said yarn having hemostatic properties and at least one said yarn having a tensile strength greater than the tensile strength of said hemostatic yarn in a wet phase, said higher strength yarn being woven, knit or braided so as to provide structural integrity to said fabric independent of said hemostatic yarn.

8. The method of claim 7 wherein said yarn having hemostatic properties is converted cellulose yarn.

9. The method of claim 8 wherein said converted cellulose yarn is sodium carboxymethylcellulose, converted after the knitting, weaving or braiding of a cellulose precursor yarn.

10. The method of claim 8 wherein said cellulose yarn is oxidized to produce oxidized cellulose fibre.

11. The method of claim 10 wherein said cellulose yarn is oxidized after the step of said weaving, knitting or braiding.

12. The method of claim 7 wherein said yarn having hemostatic properties is calcium alginate.

13. A precursor fabric capable of being converted into a composite woven, knitted or braided fabric having a capacity for absorbing a quantity of a selected fluid without losing its structural integrity, said precursor fabric comprising a network of woven, knitted or braided yarns capable of retaining the structural integrity thereof in the presence of said selected fluid and, combined therewith, precursor yarn capable of being converted to gel-forming yarn, which gel-forming yarn has a capacity to absorb said preselected fluid by forming a gel therewith.

14. A self-reinforcing composite yarn comprising

(a) reinforcing fibres or filament, and

(b) gel-forming fibres, or gel-forming fibre precursors,

wherein (b) is combined with (a) to form a continuous yarn.

15. A yarn, as in claim 14, wherein said yarn is a core-spun yarn.

16. A reinforced, gel-forming, fluid-absorbing structure comprised of a yarn, as recited in claim 14.

17. A method of making a gel-forming structure by first making a structure of a material including fibrous material which is chemically convertible to a gel-forming absorptive material, and then chemically converting said material to its gel-forming, absorptive form.

18. A method, as recited in claim 17, wherein said precursor material is a cellulosic yarn.

19. A method, as recited in claim 18, wherein said converted material is CMC.

20. A method, as recited in claim 17, wherein the finished structure is a knitted fabric

21. A method, as recited in claim 17, wherein the finished structure is a woven fabric.

22. A method, as recited in claim 17, wherein the finished structure is a braided fabric.

23. A structure, as recited in claims 20, 21 or 22, wherein the fabric is in tubular form.

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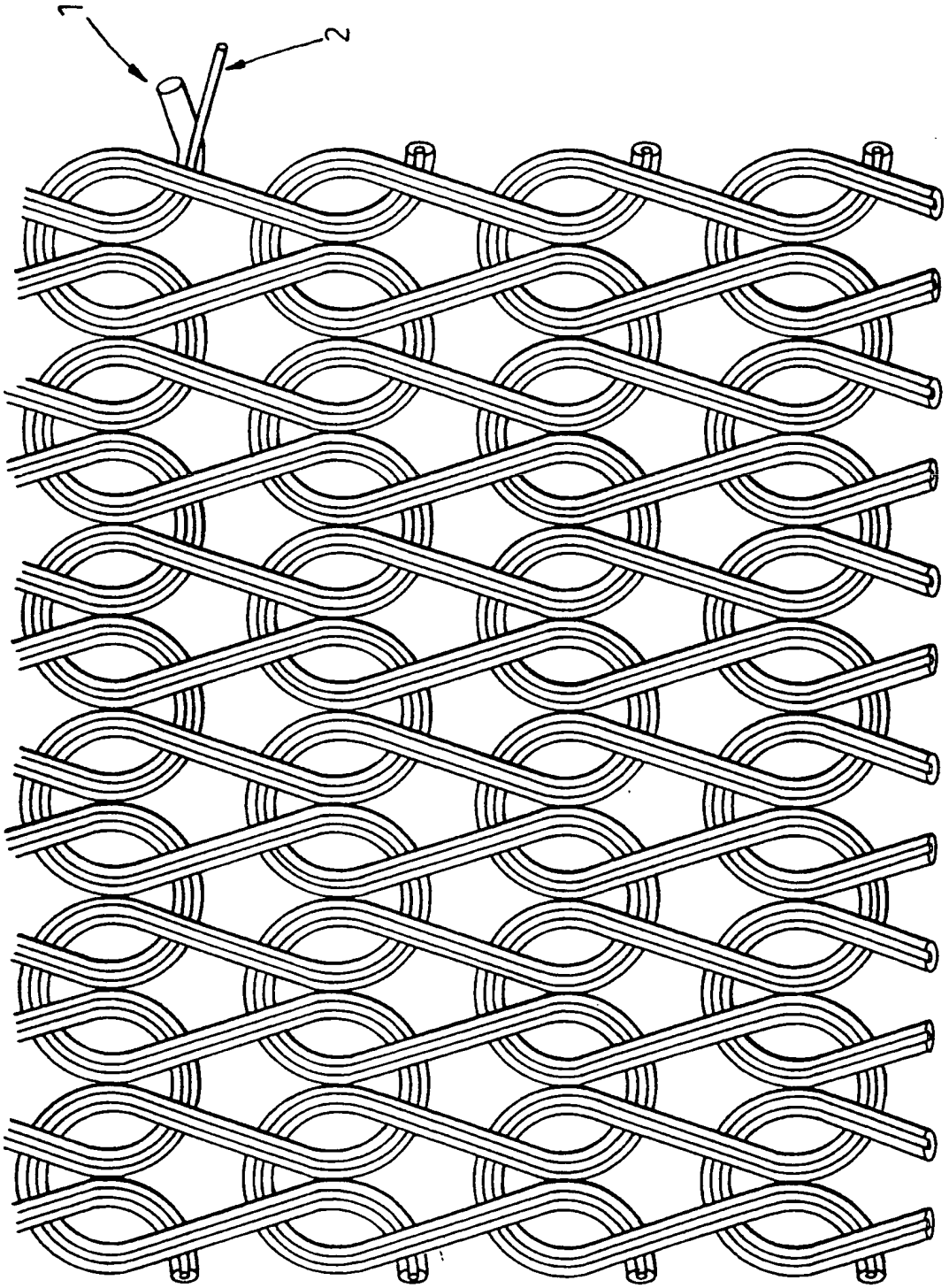

Fig. 1

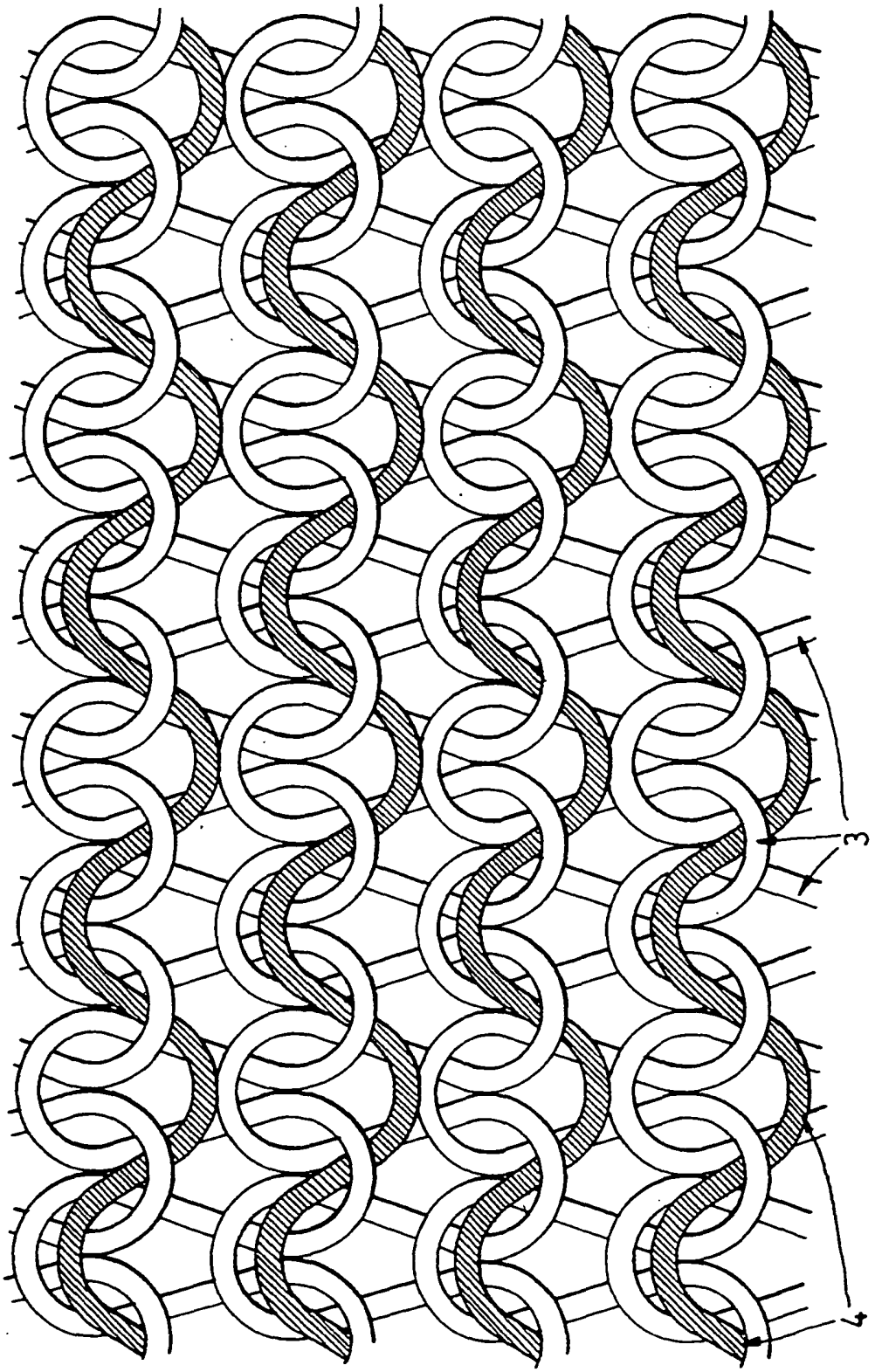

Fig. 2

INTERNATIONAL SEARCH REPORT

Intern. ıal Application No
PCT/GB 00/03586

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04B1/14 D03D15/00 D04C1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04B D03D D04C D02G A61F A61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 January 2001	16/01/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Intern ..al Application No
PCT/GB 00/03586

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

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